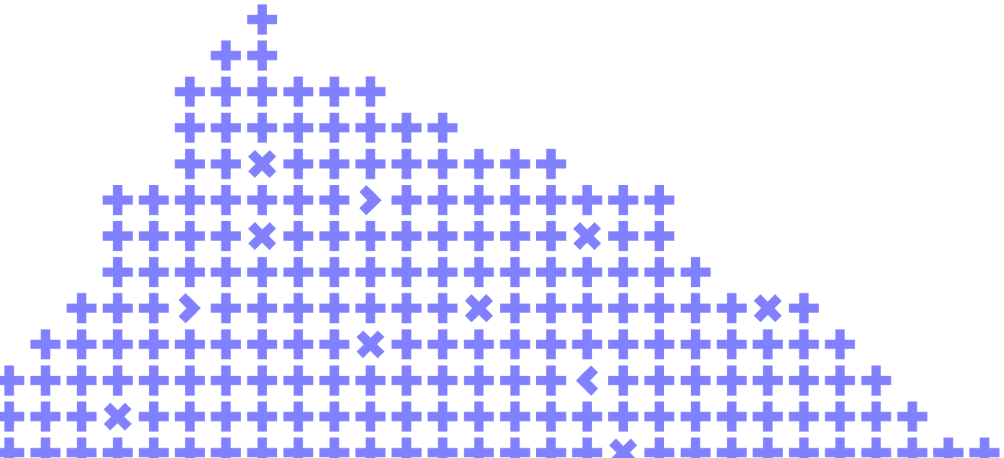
# Push notifications in RuStore: how we built an alternative transport to replace Google Firebase

Kirill Alekseev



# About me



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- Got the bachelor's degree and the master’s degree of the MSU Faculty of Computational Mathematics and Cybernetics

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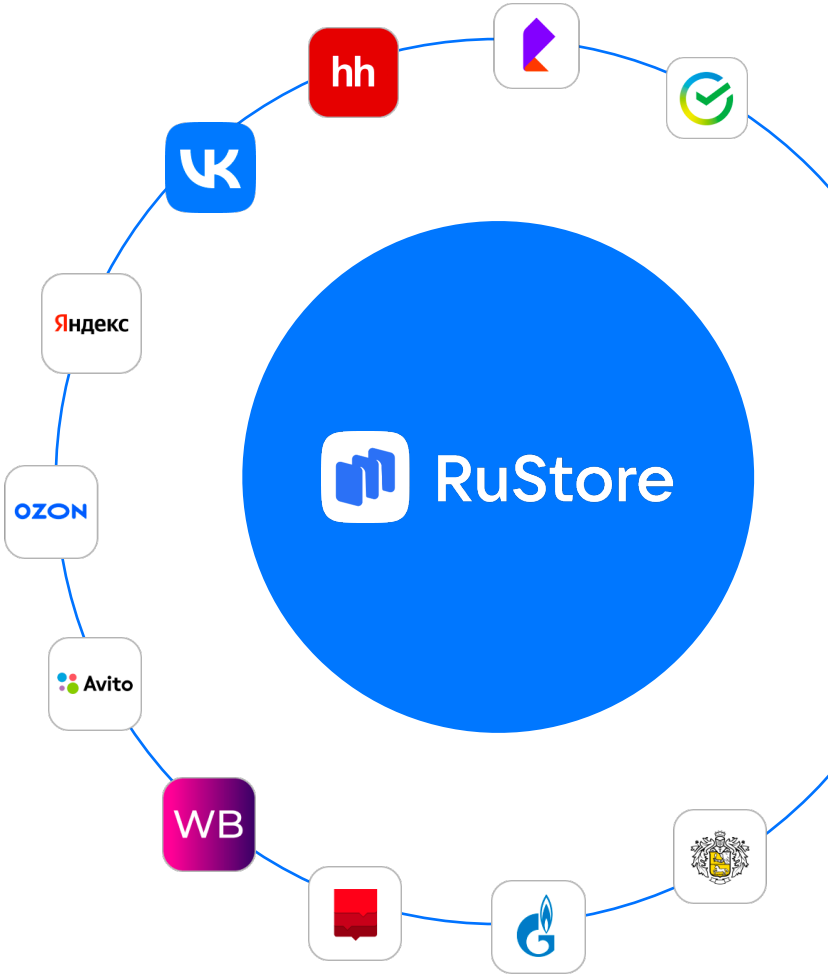
- At VK I manage several backend development teams in Mail.ru Mail Service
- Playing guitar and planning sprints at "Dela Povazhnee"

# RuStore is being developed with the contribution of the largest Russian IT companies.

Thank you for your contacts!



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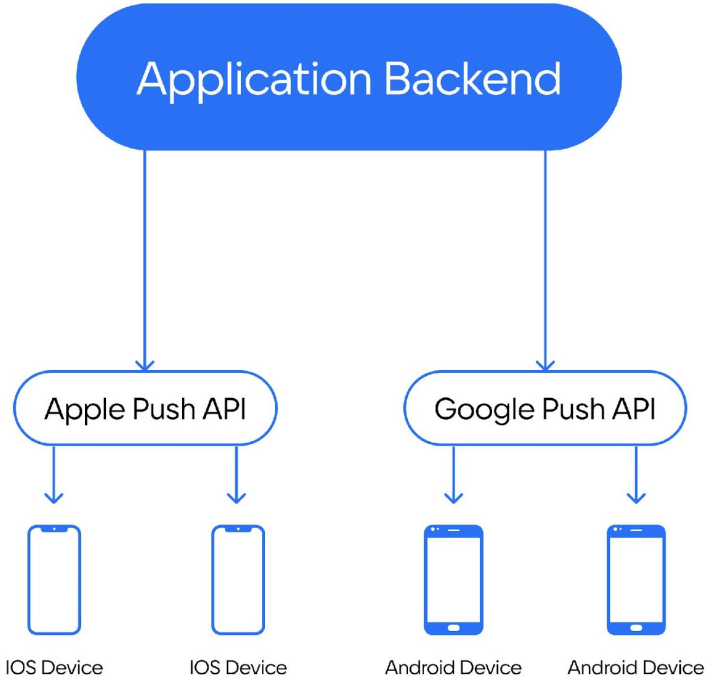
RuStore

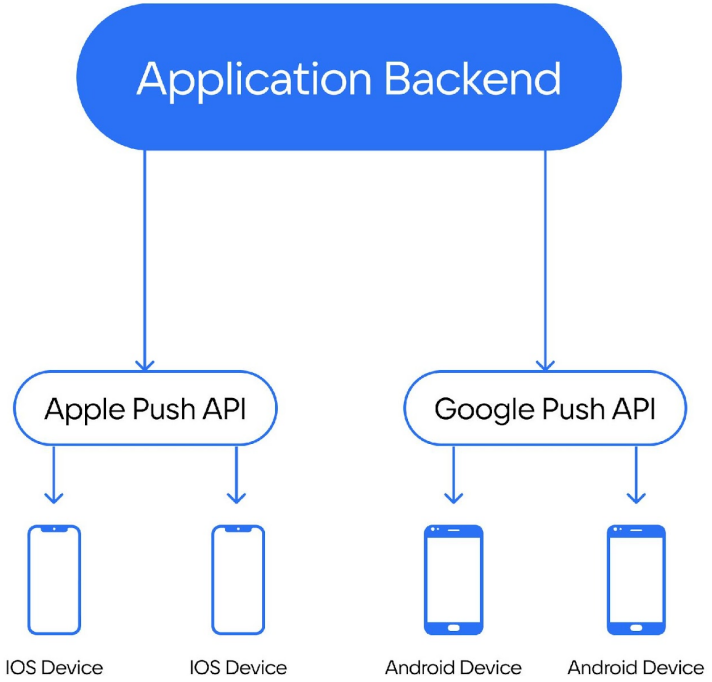
# Introduction

# Why build our own transport of push notifications



# Why build our own transport of push notifications

Push notifications are sent
via Google/Apple/Huawei API



# Why build our own transport of push notifications

Push notifications are sent
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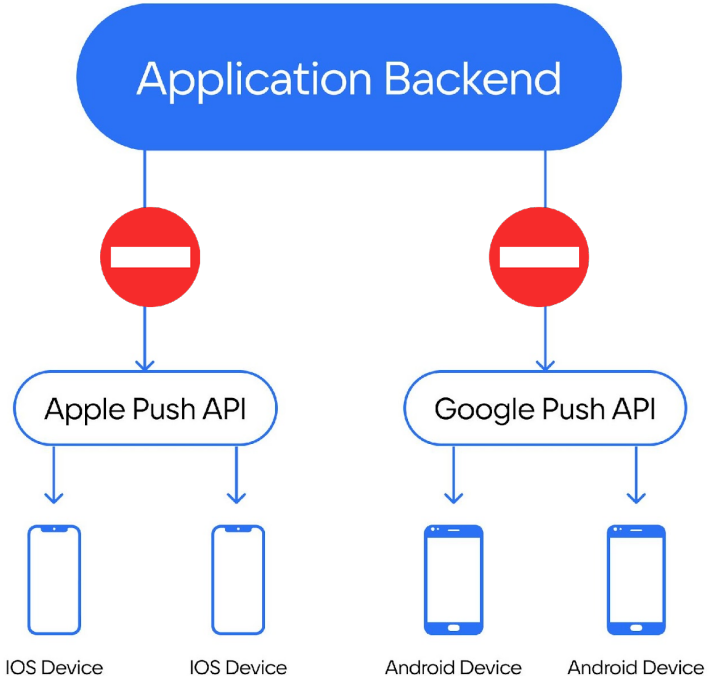
If Google decides
that we no longer need
push notifications, then
we no longer have it



# Requirements for the service

7

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- Temporary storage of push notifications while the device is offline (with TTL)
- Service must be reliable
- Service must be secure
- Easy integration into the current scheme of working with push notifications

# What any push notification looks like

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- Push token identifies the application on a specific device

```
{
  "token": "PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD",
  "title": "Kirill Alekseev\nThis is a push title",
  "body": "This is a push body",
  "some_other_useful_data": "42"
}
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# What any push notification looks like



- Push token identifies the application on a specific device
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  "token": "PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD",
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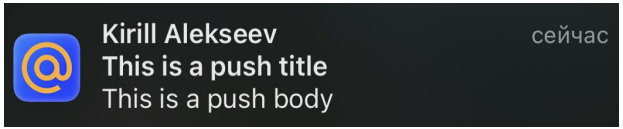

# What any push notification looks like



- Push token identifies the application on a specific device
- In a push notification, you can send an arbitrary payload and process it client-side
- Built-in push notification transports use internal OS **mechanisms that are inaccessible to us**

```
{
  "token": "PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD",
  "title": "Kirill Alekseev\nThis is a push title",
  "body": "This is a push body",
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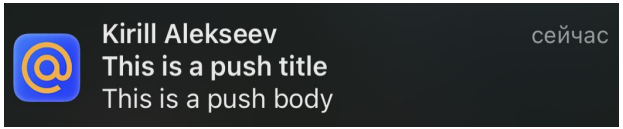

RuStore

# Overview of the service’s public part

# A web-interface to manage push notifications of application in RuStore

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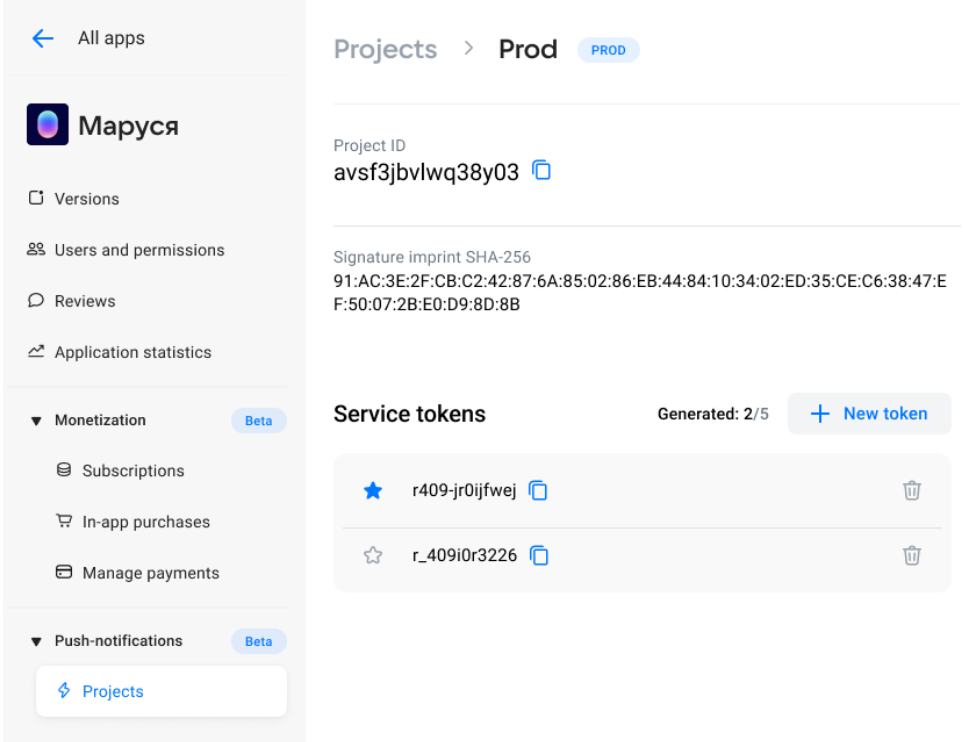
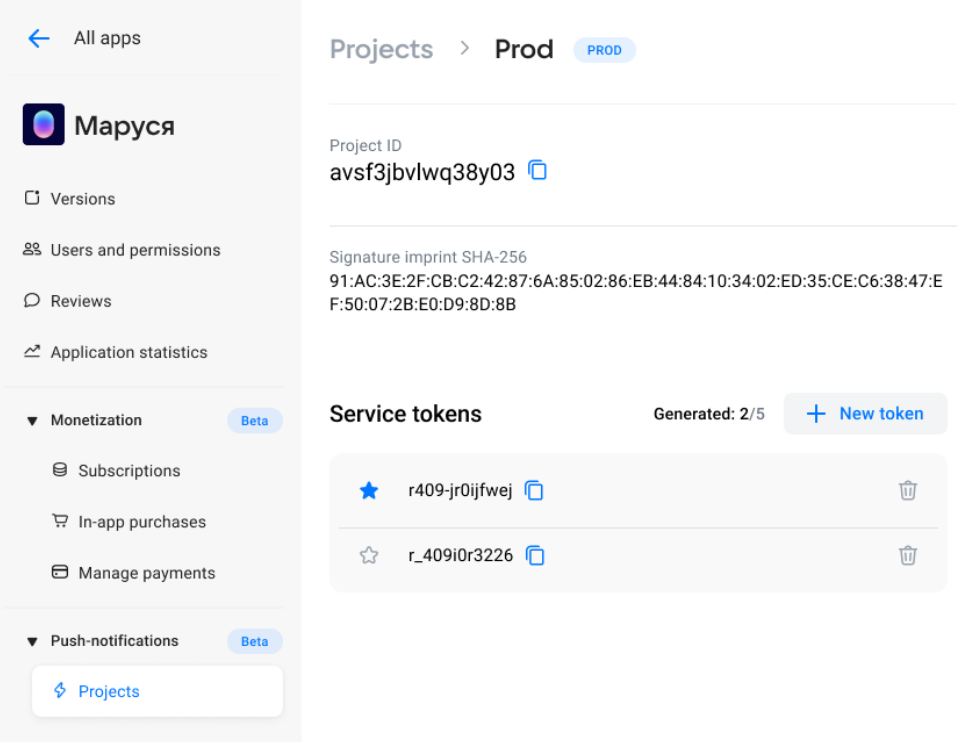



High Load ++ Armenia

# A web-interface to manage push notifications of application in RuStore






Any application is identified with the project ID

# A web-interface to manage push notifications of application in RuStore

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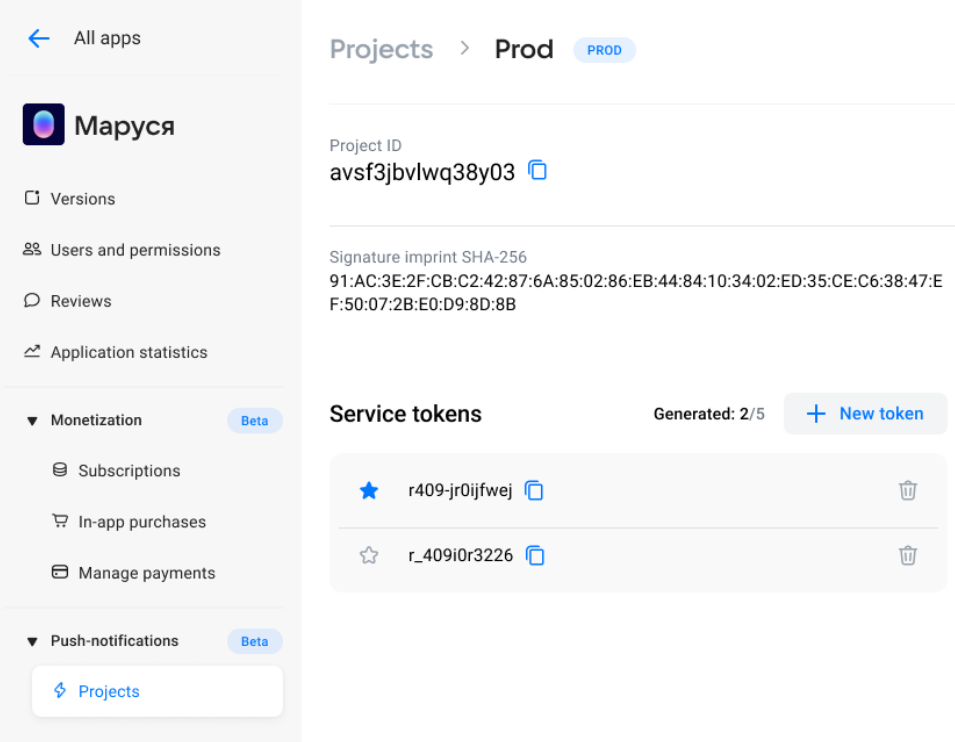
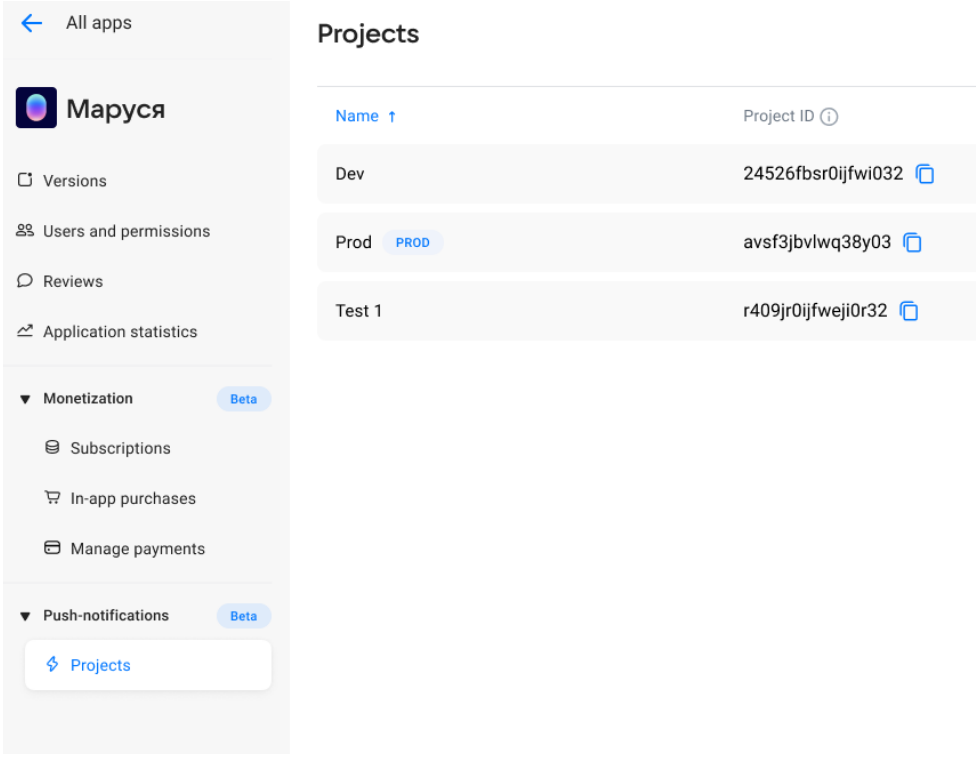



Any application is identified with the project ID

Service tokens authorize sending a push notification **and are sensitive**

# A web-interface to manage push notifications of application in RuStore



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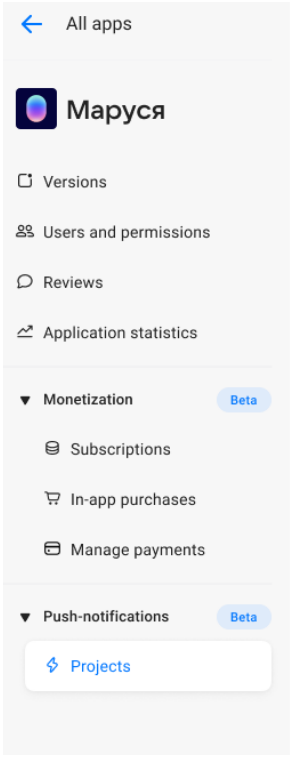


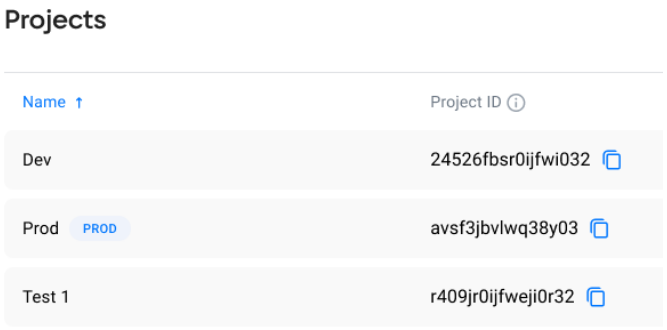


You can isolate the Dev and the Prod service tokens by linking several push projects to one application

# SDK for push service in RuStore

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# SDK for push service in RuStore



- We try to be a drop-in replacement for FCM SDK

# SDK for push service in RuStore



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- The getToken method registers and gives the application a new push token

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# SDK for push service in RuStore



- We try to be a drop-in replacement for FCM SDK
- The getToken method registers and gives the application a new push token
- The deleteToken method invalidates an existing token
- You can define callbacks onMessageReceived, onNewToken, onDeletedMessages

# RuStore Push Service API Methods



```
curl --XPOST 'https://vkpns.rustore.ru/v1/projects/admlkdas/messages:send' \
    --header 'Authorization: Bearer dasmlkads' --header 'Content-Type: application/json' \
    --data-raw '{"message":{
      "token":"PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD",
      "android":{ "notification":{ "title":"Hello, world!"} }
    }}'
```

# RuStore Push Service API Methods



- We try to be a drop-in replacement for the FCM API

```
curl --XPOST 'https://vkpns.rustore.ru/v1/projects/admlkdas/messages:send' \
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```

# RuStore Push Service API Methods



- We try to be a drop-in replacement for the FCM API
- We support both notification and data pushes, but so far a limited set of fields

```
curl --XPOST 'https://vkpns.rustore.ru/v1/projects/admlkdas/messages:send' \
    --header 'Authorization: Bearer dasmlkads' --header 'Content-Type: application/json' \
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      "token":"PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD",
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```


# Internals of our SDK

# Main
# SDK components

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# SDK components



- There are two SDKs:
"client" and "host"

# Main
# SDK components



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- "Host" is built into RuStore and collects **all push notifications for a given device**

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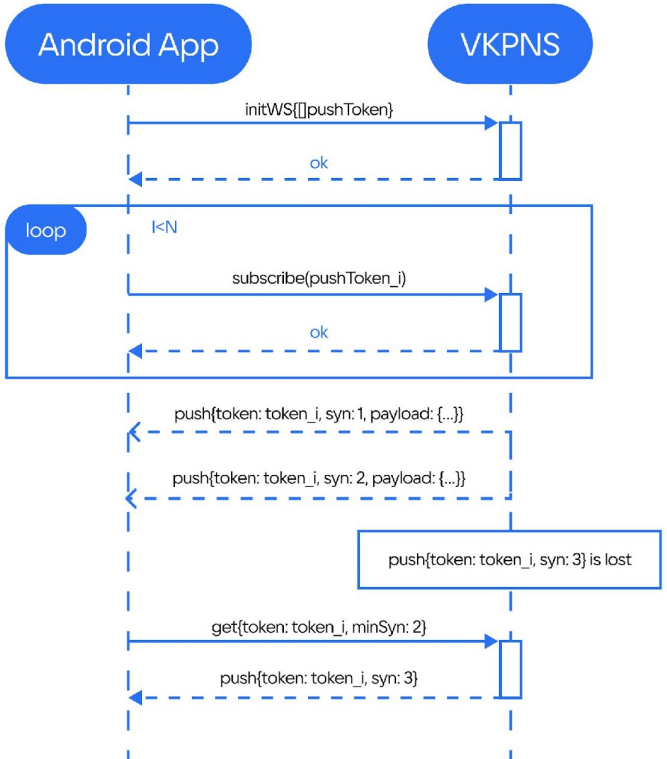
- There are two SDKs: "client" and "host"
- "Host" is built into RuStore and collects **all push notifications for a given device**
- "Client" must be integrated by the application developer (similar to the Firebase SDK)

# How SDK receives pushes

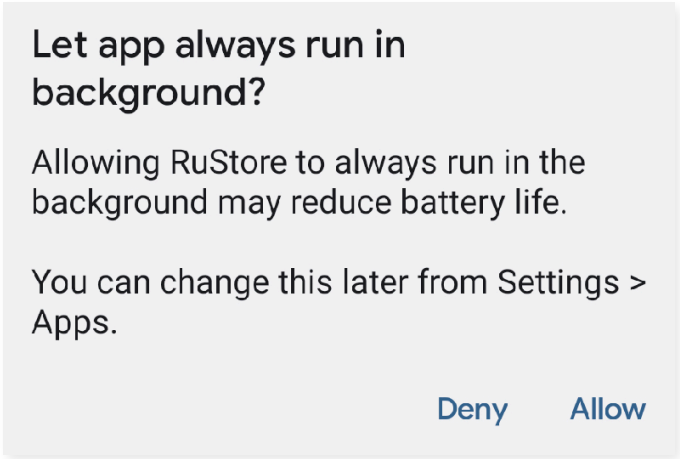
Most notifications come instantly via WebSocket, but HTTP polling is also performed periodically to deliver the lost ones.



# Fetching notifications in the background



Background instant delivery of push notifications requires a permission from the user



RuStore

# Push service backend architecture details

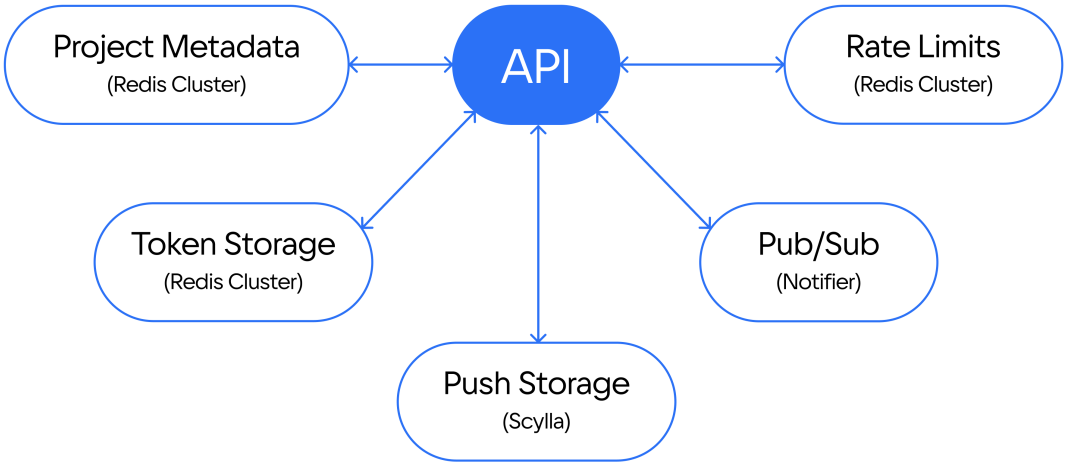
# Main components of the backend



Golang API in k8s

Redis Cluster

Scylla



# Push token storage overview

# Push token storage overview



Stored in Redis Cluster

```
hgetall token:{8B83XYXrmCYB9xFOmozIk-uZN}
1) "project_id"
2) "9TLrisVIsNfEc0DjE4clbJYsyyG9ACs4"
3) "syn"
4) "145"
7) "syn_stored"
8) “145"
```

# Push token storage overview



Stored in Redis Cluster

SYN — monotonically increasing push counter

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# Push token storage overview



Stored in Redis Cluster

SYN — monotonically increasing push counter

Requires less than 400 MB for 1 million tokens

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hgetall token:{8B83XYXrmCYB9xFOmozIk-uZN}
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```

# Push storage overview

# Push storage overview



Stored in Scylla
on disk

```
CREATE TABLE vkpns.push (
    token_id text,
    syn bigint,
    payload text,
    timestamp timestamp,
    PRIMARY KEY (token_id, syn)
) WITH CLUSTERING ORDER BY (syn ASC)
    AND bloom_filter_fp_chance = 0.01
    AND compaction = {'class': 'SizeTieredCompactionStrategy'}
    AND compression = {'sstable_compression': ‘LZ4Compressor'};
```

# Push storage overview



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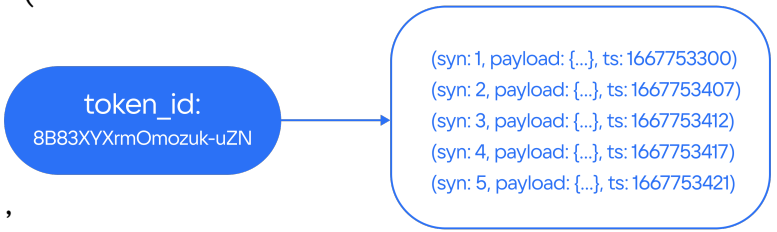

# Push storage overview



Stored in Scylla
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Allows efficient reading
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CREATE TABLE vkpns.push (
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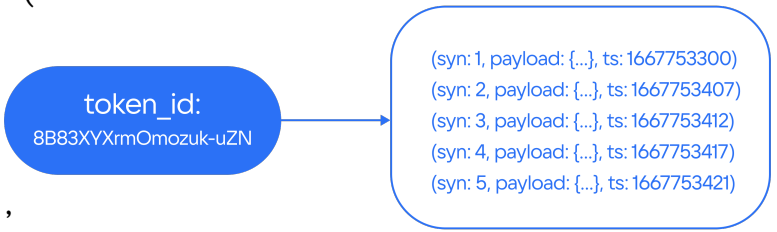

# Push storage overview



Stored in Scylla
on disk

Allows efficient reading
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LWW (Last Write Wins)
saves us from duplicate
push notifications

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CREATE TABLE vkpns.push (
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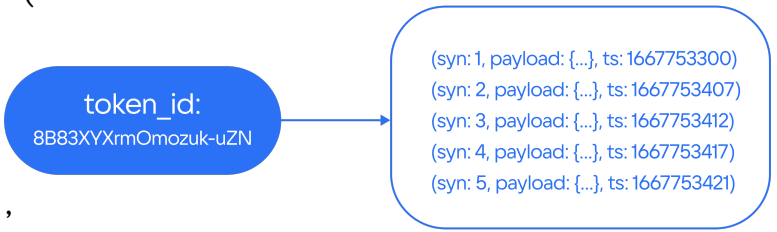

# API logic for sending a push notification



```
curl --XPOST 'https://vkpns.rustore.ru/v1/projects/admlkdas/messages:send' \
    --header 'Authorization: Bearer dasmlkads' --header 'Content-Type: application/json' \
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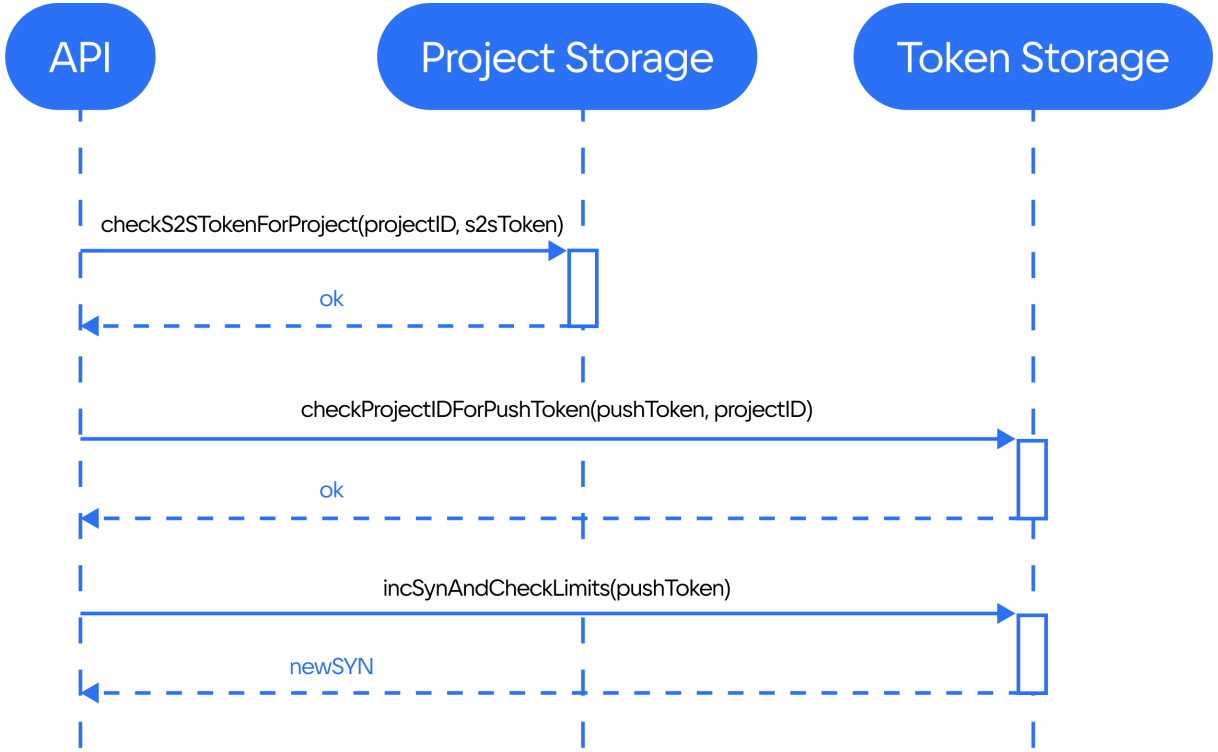

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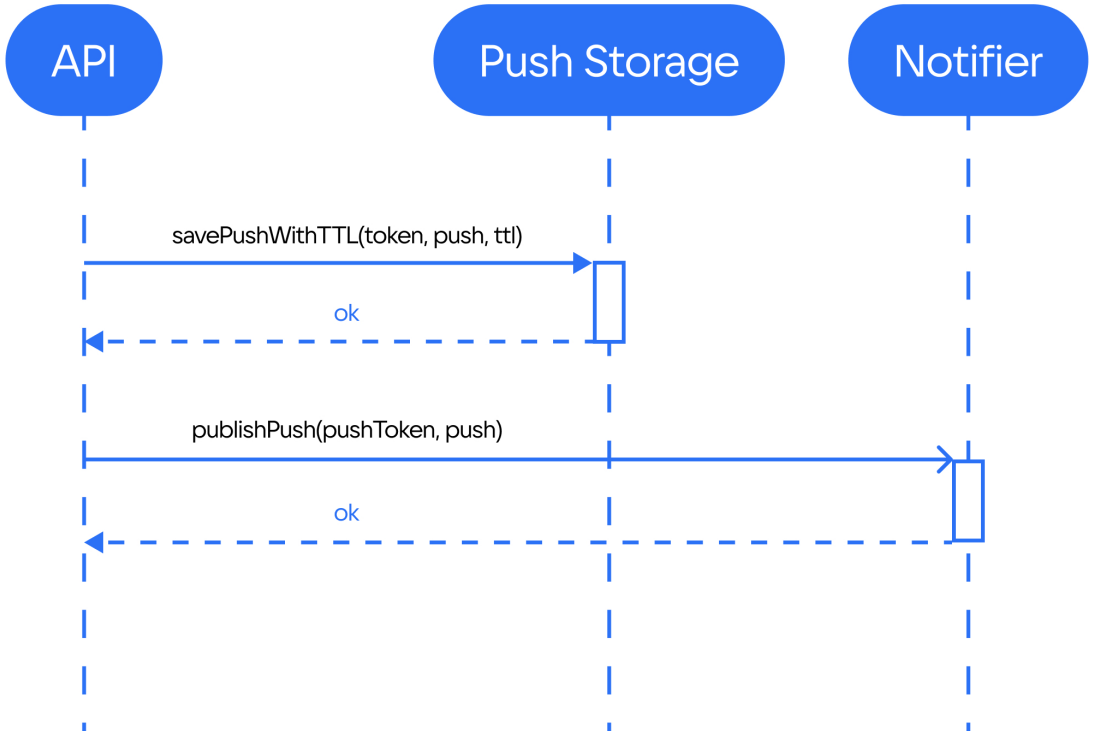

# API logic for receiving a push notification



```
curl 'https://vkpns.rustore.ru/v1/projects/messages:get' -H'Content-Type: application/
json' \
    --data-raw '{ "requests": [
        {
            "project_id": "admlkdas", "min_syn": 12, "limit": 10,
            "token": "PFGUGOBfCPZe3UOFU3UflV8qPGUddEBD"
        }
    ]}'
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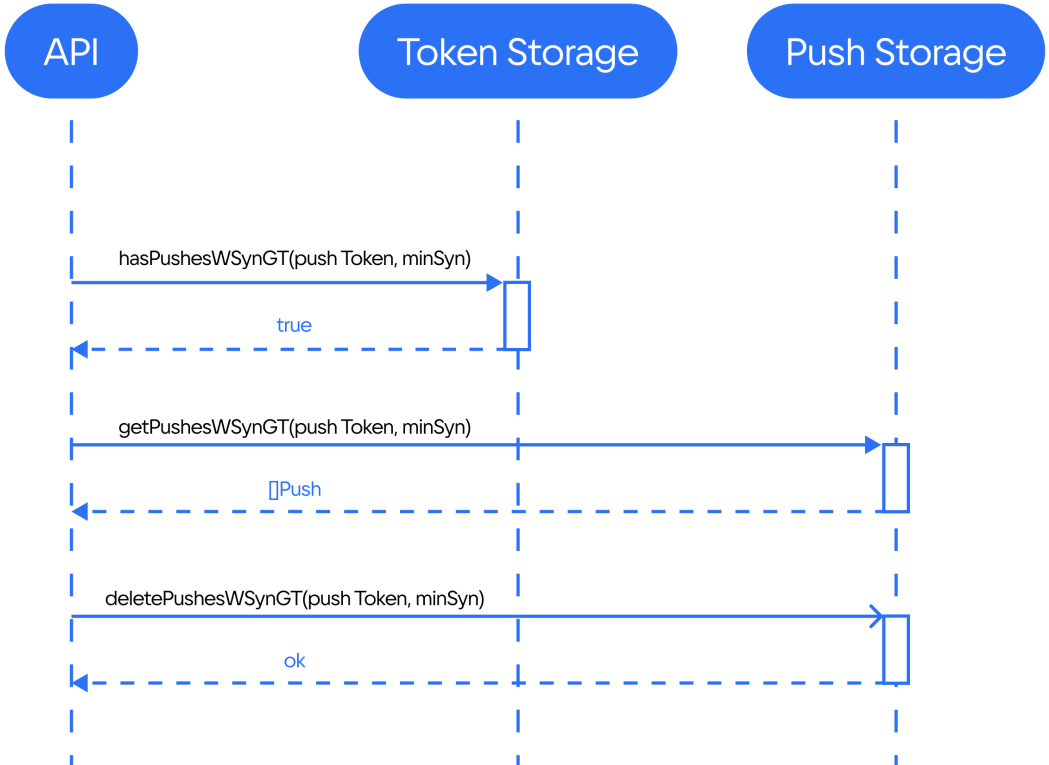
# API logic for receiving a push notification



# How not to overload the storage with stale push tokens

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# How not to overload the storage with stale push tokens



- Reasons why stale tokens appear:

# How not to overload the storage with stale push tokens



- Reasons why stale tokens appear:

  app has been removed

# How not to overload the storage with stale push tokens



- Reasons why stale tokens appear:

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  phone got lost

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???

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- All push tokens have a TTL in the token storage

# How not to overload the storage with stale push tokens



- Reasons why stale tokens appear:

  app has been removed

  phone got lost

  ???

- All push tokens have a TTL in the token storage

- Automatically update the lifetime of the token, if the client comes for pushes

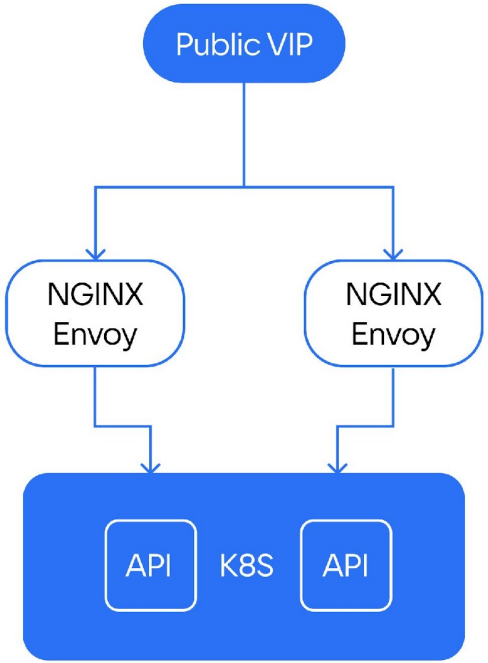

# Why we won't be down (at least for too long)

# Fault tolerance at the API level

API lives in Kubernetes

Kubernetes lives in 5 DCs

Pod healthchecks configured in Envoy



# Redis Cluster for Storage of push tokens

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- Scales horizontally thanks to:

# Redis Cluster for Storage of push tokens



- Scales horizontally thanks to:

  - automatic resharding

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  - routing of read queries to replicas

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- Fault-tolerant in case of a node/datacenter failure thanks to:

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- Fault-tolerant in case of a node/datacenter failure thanks to:

  - automatic failover (with short downtime)

# Redis Cluster for Storage of push tokens



Scales horizontally thanks to:

- automatic resharding
- routing of read queries to replicas

Fault-tolerant in case of a node/datacenter failure thanks to:

- automatic failover (with short downtime)
- retries of read queries to another replica

# Scylla for Storage of pushes

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- Scales horizontally with automatic resharding

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- Scales horizontally with automatic resharding
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# Scylla for Storage of pushes



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~~Million~~

# 10 million WebSockets and Go

# ~~Million~~
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- The service has been successfully operated in Mail.ru Mail Service for five years

# ~~Million~~
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- Resistant to one DC failure

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- The service has been successfully operated in Mail.ru Mail Service for five years
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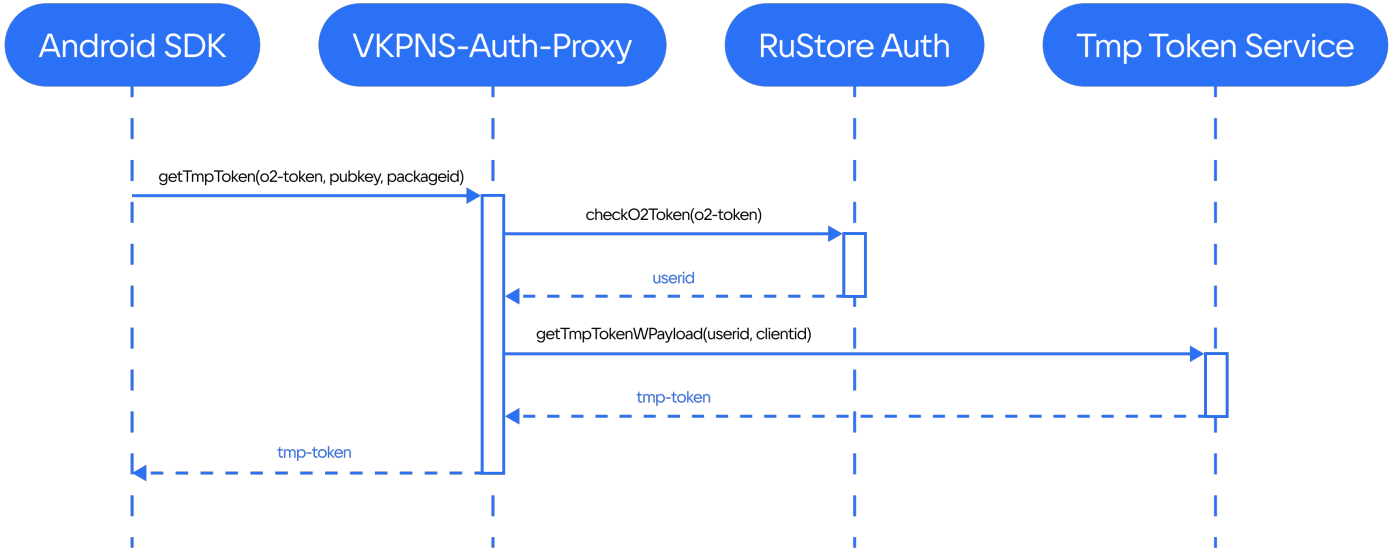
# DoS protection on generation of push tokens





# DoS protection
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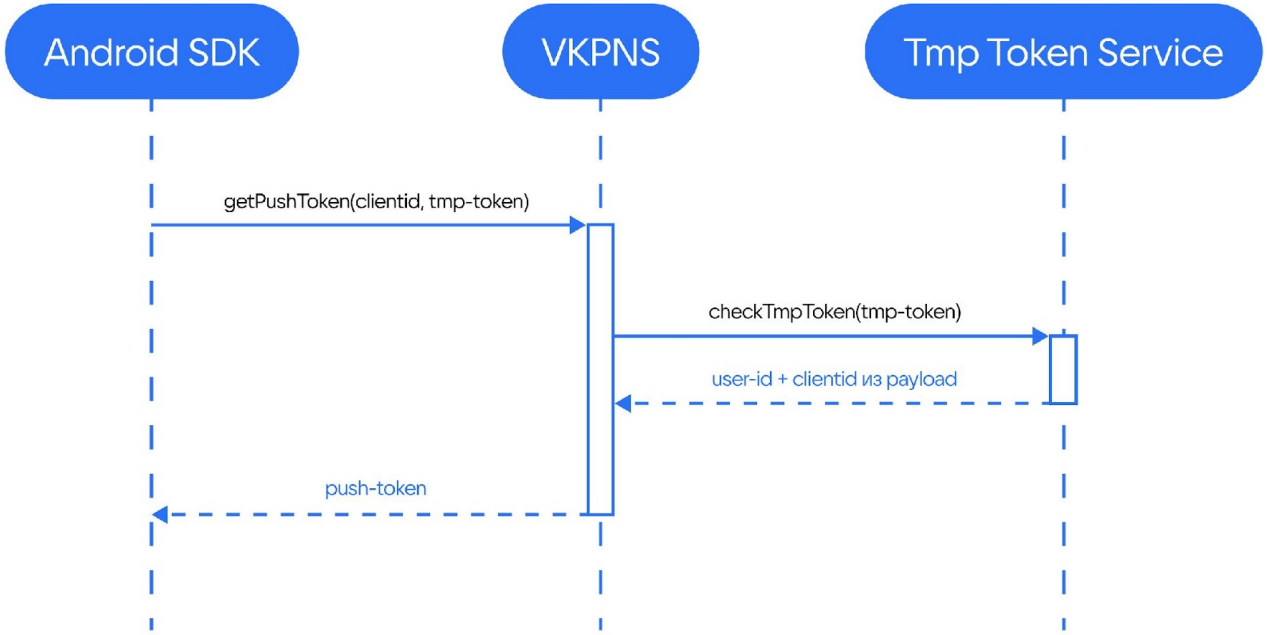

RuStore

# How we integrated RuStore push notifications into Mail.ru Mail Service

# Integration process to Mail.ru Mail Service

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- Started sending push notifications through RuStore in parallel with FCM

# Integration process to Mail.ru Mail Service



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- Measured the number of delivered push notifications per hour

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- Will start showing the push that came before

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- Fixed bugs in the push service and analytics
- Will start showing the push that came before
- Will measure delivery latency

# Integration process to Mail.ru Mail Service



- Started sending push notifications through RuStore in parallel with FCM
- Measured the number of delivered push notifications per hour
- Fixed bugs in the push service and analytics
- Will start showing the push that came before
- Will measure delivery latency
- Will reduce delivery latency

# Complexity of integration

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- The interface of our SDK repeats the interface of the FCM SDK
- The push notification sending API is a drop-in replacement for the FCM API

# Benefits of integration

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- We can increase the delivery rate by sending via two channels in parallel
- Carried out load testing of RuStore push notifications in real conditions

# Midterm results (VKPNS vs FCM)

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- Push notification deliverability per day: ~101% vs 100%

# Future plans

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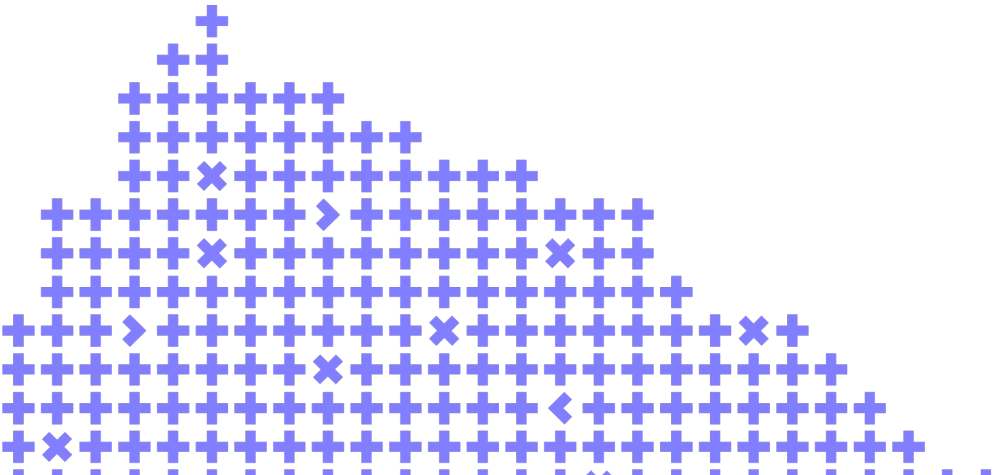
- Get closer in functionality to FCM (broadcasting by topics, more push settings, show deliverability metrics)
- Start receiving push notifications through other VK applications on the user's device
- Maintain health metrics no worse than that of Google FCM

# Leave your feedback!

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